

Regional Interpretation - Intermountain West

The Intermountain West includes the Columbia River Basin and Snake River Plateau in the northwest, the Great Basin in Nevada and western Utah, and the Colorado Plateau in the Four Corners area of Utah, Arizona, New Mexico and Colorado (Figure 1). In addition to large areas of forest, this region has the highest proportion of Federal lands (Figure 2). Much of the rangeland in the Intermountain West is characterized by plant communities that were historically dominated by bunchgrasses and shrubs (Cronquist et al. 1977). Typical bunchgrasses include bluebunch wheatgrass [*Pseudoroegneria spicata* (Pursh) Á. Löve], Idaho fescue (*Festuca idahoensis* Elmer), Sandberg's bluegrass (*Poa secunda* J. Presl), various needlegrass spp., (*Stipa* spp.), dropseed spp. (*Sporobolus* spp.), and prairie junegrass [*Koeleria macrantha* (Ledeb.) Schult]. Sagebrush (*Artemisia* spp.) and juniper (*Juniperus* spp.) with pinyon pine (*Pinyon* spp.), mountain mahogany (*Cercocarpus* spp.), salt desert shrub (*Atriplex* spp and others), and greasewood (*Sarcobatus* spp.) are found throughout various shrub vegetation types. In Intermountain West vegetation, a shrub canopy zone often exists with a dominant shrub, an understory and interspace area consisting of smaller shrubs, bunchgrasses, forbs, and biological soil crusts (lichens, mosses and cyanobacteria at the soil surface). Intermountain West plant communities are especially susceptible to non-native exotic plants due to a combination of disturbances such as heavy grazing, frequent wildfires, and vehicular traffic. Exotic annual grasses can negatively impact biotic integrity, ecosystem stability, composition and structure, natural fire cycles, diversity, soil biota, vegetation production, forage quality, wildlife habitat, soil physical properties, organic matter dynamics, carbon balance, ,nutrient and energy cycles, and hydrology and erosion dynamics (Chapin et al. 2000; Evans et al. 2001; Pierson et al. 2002; Ehrenfeld 2003; Ogle et al. 2003; Brooks et al. 2004; Norton et al. 2004, Belnap et al. 2005; Hooper et al. 2005; Sommer et al. 2007, Boxell and Drohan 2008; Herrick et al. 2010, Davies 2011).

Dramatic soil variability, driven by geology (soil parent material) and subsequent landscape formation, contribute to large differences in potential plant community composition. Soil-driven differences in plant communities are particularly evident in many parts of Utah, where salt-affected soils cover large areas (e.g., Bonneville Salt Flats). Large precipitation gradients and differences in potential evaporation and transpiration associated with aspect and elevation (lower on north-facing slopes and higher on south- and west-facing slopes) also contribute to variability in ecological potentials in this region. There are some significant localized areas of irrigated agriculture. Where cropland fields have been abandoned, they revert to rangeland, often with a predominance of non-native invasive plants.

Figure 1. Broad Regions Described in these Interpretations.

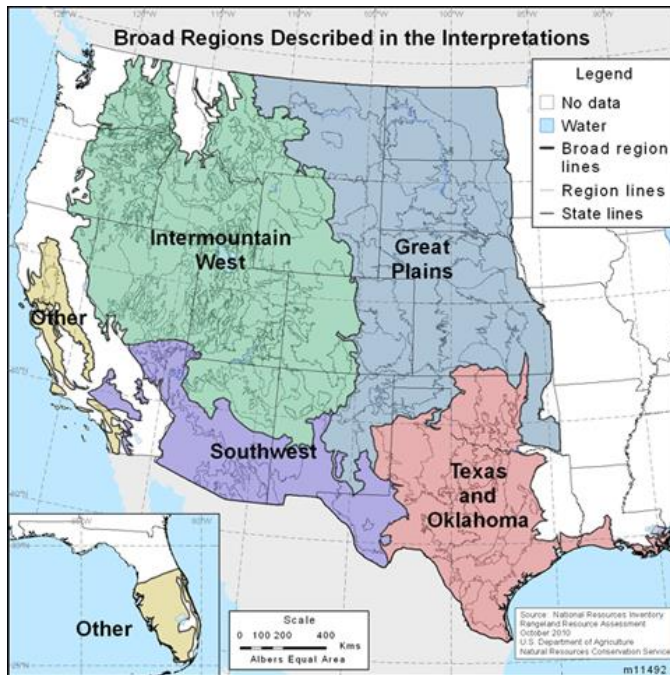
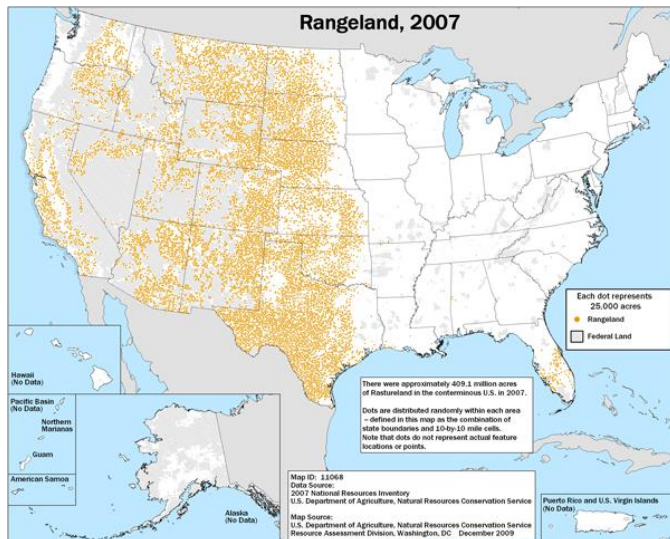


Figure 2. Acres of Non-Federal Rangeland, 2007.



Since neither Federal land nor forest land was included in the NRI rangeland on-site data collection, results in this region, with the exception of eastern Washington, should be carefully interpreted. Although the maps and tables accurately reflect the results on non-Federal rangeland, they show the status of a small proportion of the region as a whole (Figure 2).

Soil and Site Stability

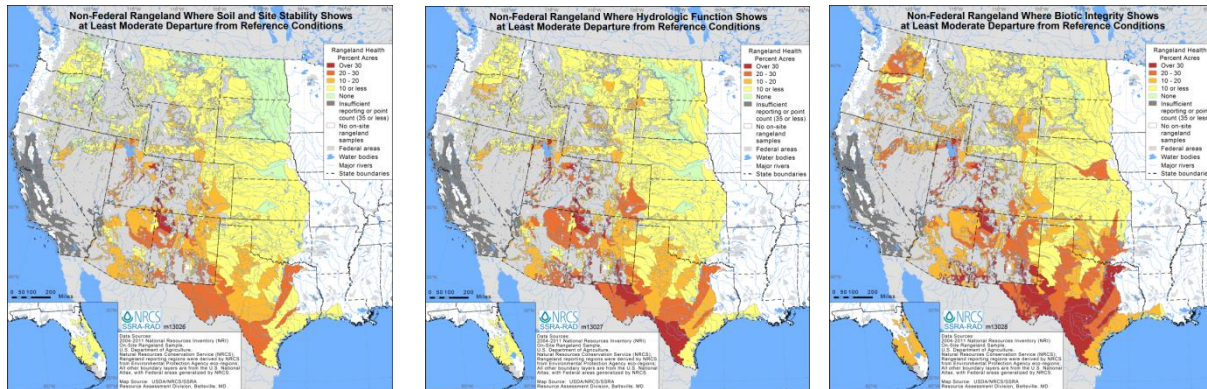
The northern part of the Intermountain region shows 10% or less of non-Federal rangeland has at least moderate departure from reference conditions for soil and site stability; however, the southern part of the region shows higher percentages of non-Federal rangeland with moderate or greater departure from reference conditions for that rangeland health attribute (Figure 3). The southern areas typically have lower precipitation and higher evaporation and transpiration rates. In the southern area where soil and site stability with at least moderate departure from reference conditions is more prominent, higher percentages of bare ground (20-50%; Figures 4-7), canopy gaps in the vegetation with bare ground (Figures 8-9), and less stable soil aggregates are found (Figure 10). In addition, juniper (*Juniperus* spp.) is common throughout this region and in many areas juniper densities and canopy closure are increasing. Figures 10-12, respectively, show areas of non-Federal rangeland where Pacific junipers, Montane/Inter-Montaine junipers, and Southern junipers (Species in these groups are listed in Native Invasive Woody Species Table 1.) make up at least 30 percent of the plant canopy cover. In many of the southern areas of the Intermountain West region, there are also fairly large areas of saline soils where other shrub species such as greasewood (*Sarcobatus vermiculatus* (Hook.) Torr.) and saltbush (*Atriplex* spp.) are endemic, with little understory and interspace vegetation. All of these factors may contribute to lower resistance and resilience to degradation (Weltz and Spaeth 2012; Weltz et al. 2014).

Figures 3-5. Non-Federal Rangeland Where Soil and Site Stability, Hydrologic Function, or Biotic Integrity Show at Least Moderate Departure from Reference Conditions. (Source: Rangeland Health Table 2)

Figure 3. Soil and Site Stability

Figure 4. Hydrologic Function

Figure 5. Biotic Integrity



Figures 6-7. Non-Federal Rangeland that is at Least 20, 30, 40, or 50 Percent Bare Ground (Source: Bare Ground, Inter-Canopy Gaps, and Soil Aggregate Stability Table 2)

Figure 6. At Least 20%

Figure 7. At Least 30%

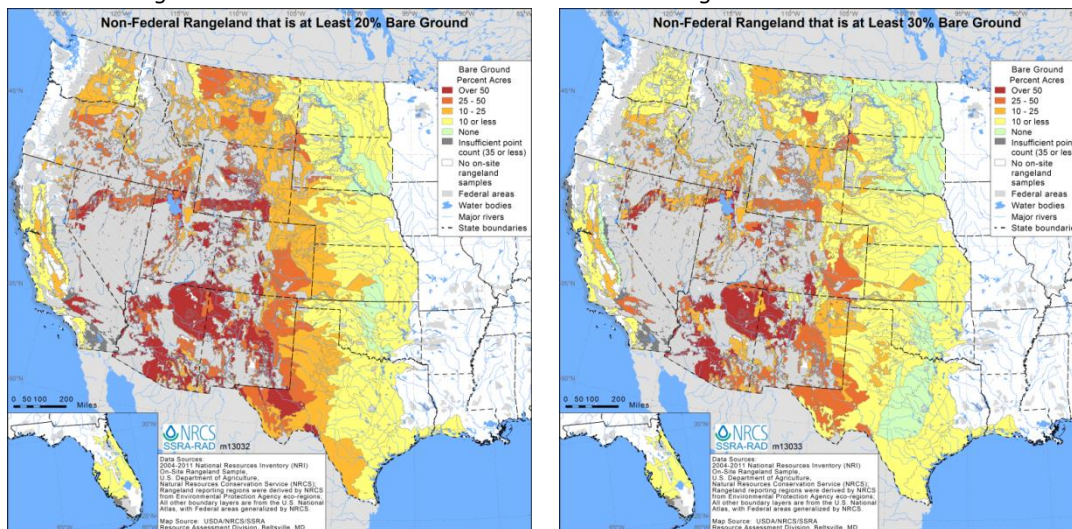


Figure 8. At Least 40%

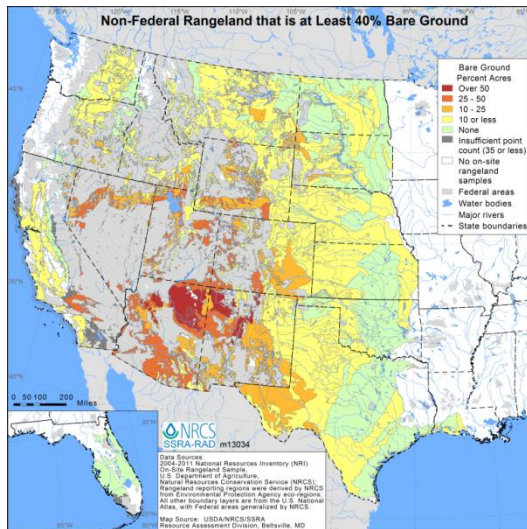
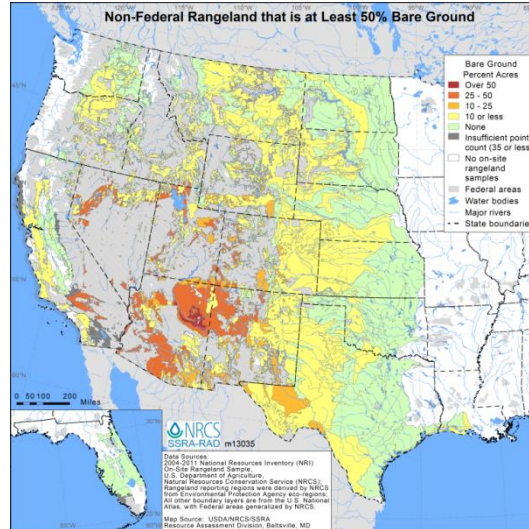


Figure 9. At Least 50%



Figures 10-11. Non-Federal Rangeland Where Canopy Gaps of at Least 1 or 2 Meters Account for at Least 20 Percent of the Land and Inter-Canopy Gaps are at Least 50% Bare Ground (Source: Bare Ground, Inter-Canopy Gaps, and Soil Aggregate Stability Table 3)

Figure 10. 50% Bare Ground in Gaps of at Least 1 Meter

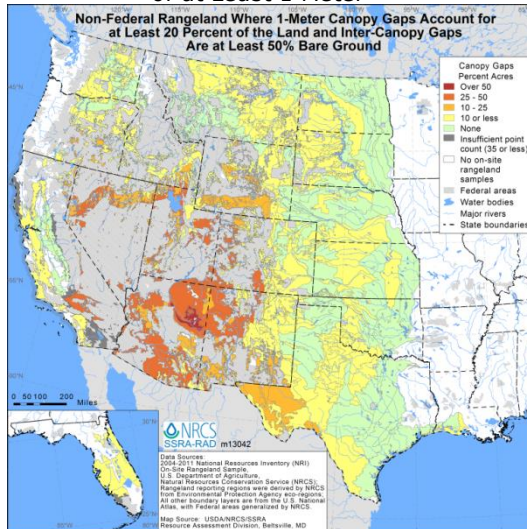


Figure 11. 50% Bare Ground in Gaps of at Least 2 Meters

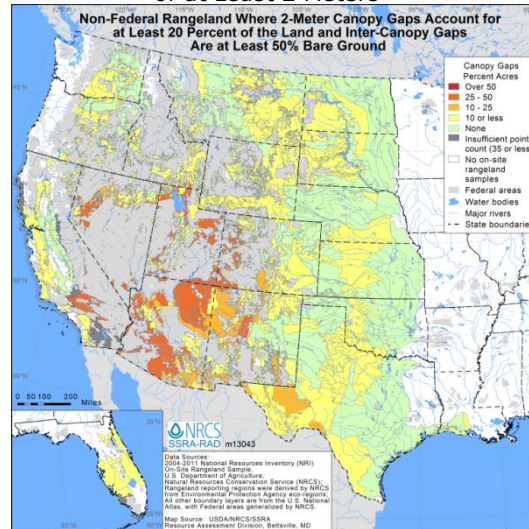
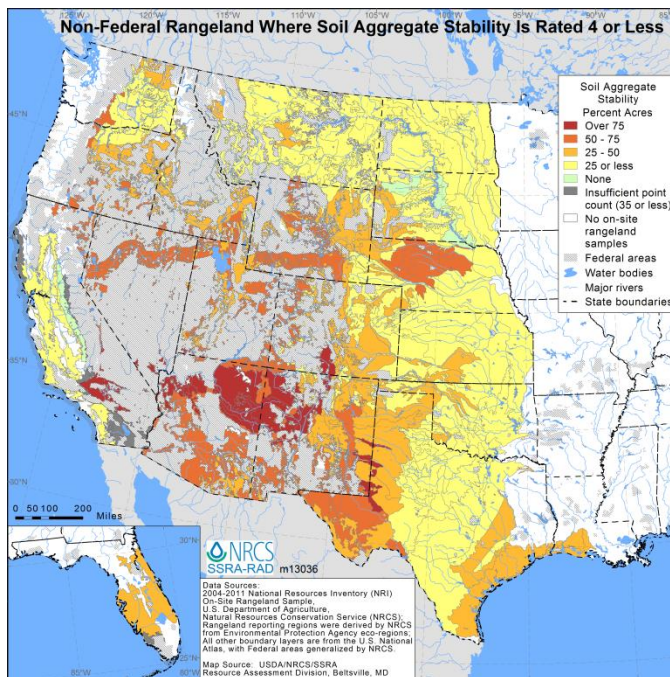


Figure 12. Non-Federal Rangeland Where Soil Aggregate Stability is 4 or Less Indicating Unstable Soil (Source: Bare Ground, Inter-Canopy Gaps, and Soil Aggregate Stability Table 4)



Figures 13-15. Non-Federal Rangeland Where Pacific, Montane / Inter-Montane, and Southern Juniper Species Cover at Least 30 Percent of the Soil Surface. (Source: Native Invasive Woody Species Tables 1, 2, 4, and 6)

Figure 13. Pacific Juniper Species

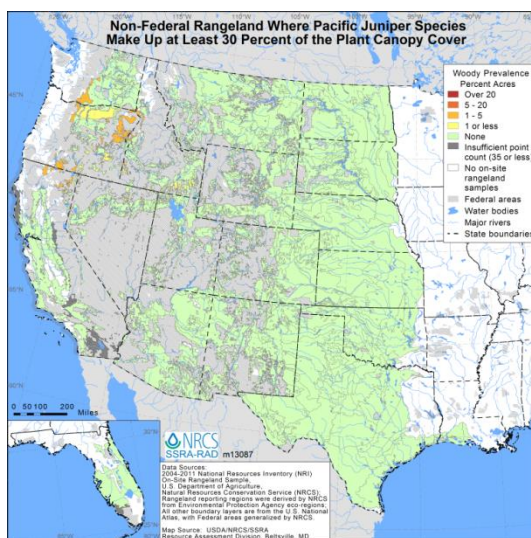


Figure 14. Montane / Inter-Montane Juniper Species

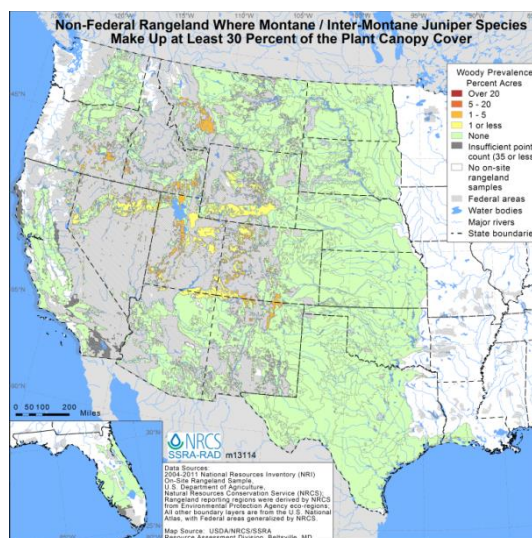
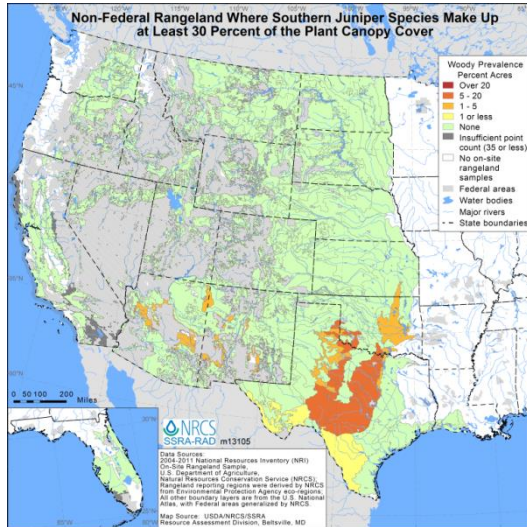


Figure 15. Southern Juniper Species



On sites where juniper is invasive, understory vegetation consisting of grasses, forbs, and other lower statured shrubs such as sagebrush typically decrease as juniper canopy increases (Pierson et al. 2007; Pierson et al. 2010; Weltz and Spaeth 2012). This creates both soil and site instability and decreased hydrologic function. In healthy sagebrush steppe ecosystems, shrub clusters and coppice dunes often accumulate windblown soil and litter and are associated with high rates of infiltration; these areas can collect runoff water from surrounding lands (Blackburn et al. 1990). As interspace vegetation decreases, more inter-canopy gaps devoid of vegetation and macrobiotic crusts form. These gaps are highly susceptible to wind and water erosion, particularly following disturbance (e.g., by animals, vehicles, or machinery). As the amount of bare ground increases and patches of bare ground coalesce, ecological thresholds are crossed and degradation accelerates. Natural water flow paths become eroded between mature juniper and often develop into rills and gullies. Soil loss down to bedrock is common. Degraded conditions may be permanent depending on the resiliency of the vegetation dynamics within the site (Pierson et al. 2010; Weltz and Spaeth 2012).

Hydrologic Function

The pattern of departure from reference conditions for hydrologic function is shown in Figure 4. A loss of herbaceous understory and associated increases of bare ground and canopy gaps lead to reduced infiltration capacity and increased runoff (Pierson et al. 2007; Pierson et al. 2010; Weltz and Spaeth 2012). Where bare ground is concentrated in large inter-canopy gaps, the effect is even more pronounced. In this region, when soil and site stability and hydrologic function are compromised by excessive soil loss, thresholds are crossed and recovery to original historical ecological states is unlikely (Weltz and Spaeth 2012; Weltz et al. 2014).

Biotic Integrity

Biotic integrity in much of this region has been reduced (Figure 15) by the replacement of native grasses with non-native annual grasses such as medusahead (*Taeniatherum caput-medusae* (L.) Nevski; Figure 16) and annual brome species (*Bromus* spp.; Figure 17) such as cheatgrass (*Bromus tectorum* L; Figure 18) and invasive forb species including the knapweed-starthistle complex (*Centaurea* spp.; Figure 19). Sagebrush stands become degraded by subsequent invasion of juniper and increased occurrence and frequency of wildfires due to the invasion of non-native annual grasses, which can produce an abundance of dry flammable fuels (Brooks et al. 2004; Pierson et al. 2010). A number of studies have demonstrated that shifts to invasive species decreases native biodiversity, which can have significant effects on nutrient cycling, hydrologic function, livestock forage quantity and quality, and wildlife habitat (DiTomaso 2000; Mack et al. 2000; Evans et al. 2001). Rehabilitation of invasive plant-dominated lands has traditionally involved the seeding of adapted non-native introduced forage grasses, such as crested wheatgrass (*Agropyron cristatum* (L.) Gaertn.), especially where livestock production on non-Federal lands is the primary land use. Although crested wheatgrass is easier to establish than many native grasses, and can provide perennial cover quickly, a monoculture is usually established where biodiversity and other functions such as nutrient cycling, hydrologic function, quality of livestock forage, and wildlife habitat are altered compared to conditions in historic plant communities (DiTomaso 2000; Vaness and Wilson 2007).

Figure 16-19. Non-Federal Rangeland Where Annual Bromes, Cheatgrass, Medusahead, or Centaurea Is Present. (Source: Non-Native Plant Species Tables 1, 3, 5, 7, and 15)

Figure 16. Annual Bromes

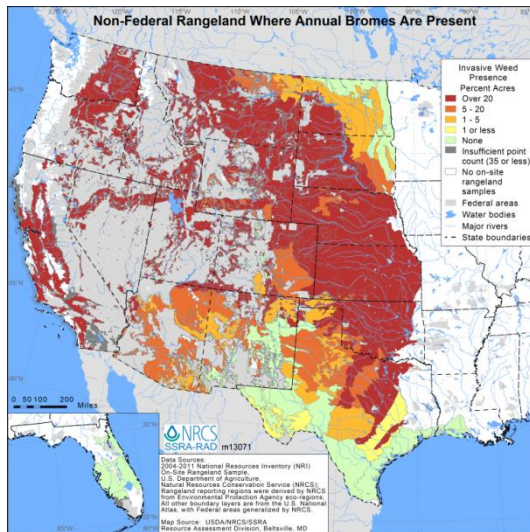


Figure 17. Cheatgrass

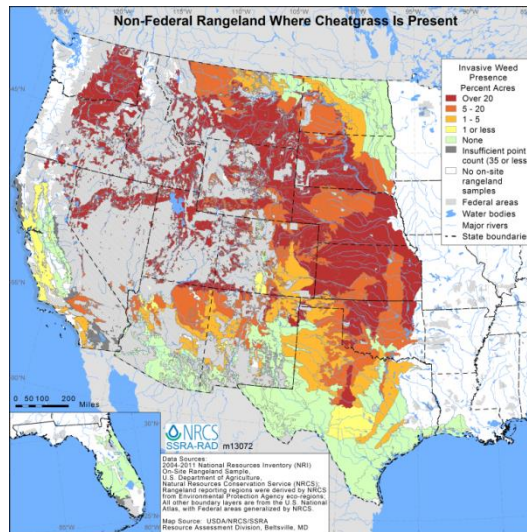


Figure 18. Medusahead

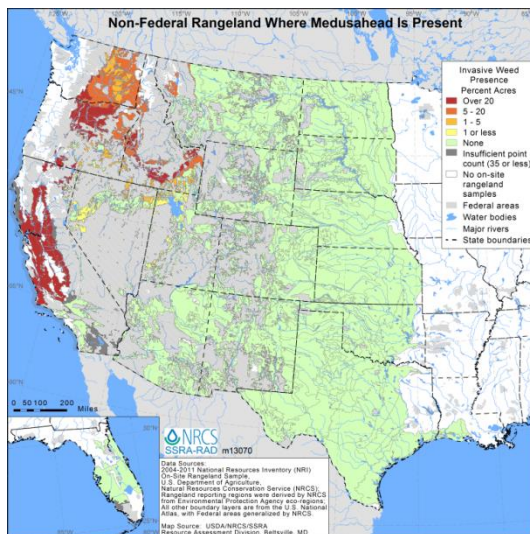
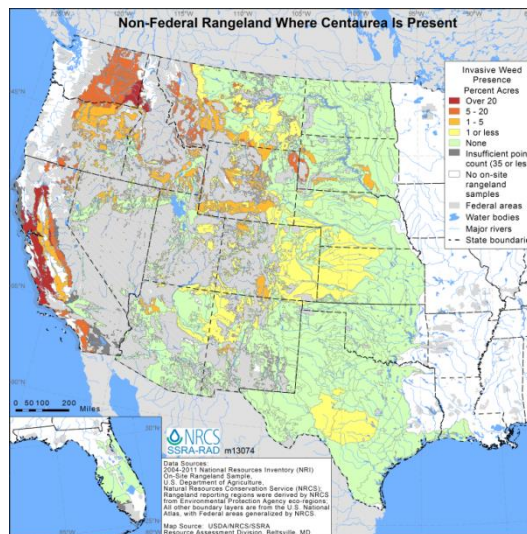


Figure 19. Centaurea



More Information

Cronquist A, A.H. Holmgren, N.H. Holmgren, J.R. Reveal, and P.K. Holmgren. (1977). Intermountain flora: Vascular plants of the Intermountain West, U.S.A. Vol. 6. The Monocotyledons. Columbia University Press, New York

Blackburn W.H., F.B. Pierson, and M.S. Seyfried. (1990). Spatial and temporal influence of soil frost on infiltration and erosion of sagebrush rangelands. *Water Resources Bull.* 26:991-997.

Chapin III, F.S., Zavaleta, E.S., Eviner, V. ., Naylor, R.L., Vitousek, P.M., Reynolds, H.L. & Díaz, S. (2000). Consequences of changing biodiversity. *Nature*, 405(6783), 234-242.

DiTomaso J.M. (2000). Invasive weeds in rangelands: species, impacts, and management. *Weed Science* 48:255-265.

Mack R.N., D. Simberloff, W.M. Lonsdale, H. Evans, M. Clout, and F.A. Bazzaz. (2000). Biotic invasions: causes, epidemiology, global consequences, and control. *Ecological Applications* 10:689-710.

Evans R.D., R.Rimer, and S.P. Belnap. (2001). Exotic plant invasion alters nitrogen dynamics in an arid grassland. *Ecol. Appl.* 11:1301-1310.

Pierson F.B., D.H. Carlson, and K.E. Spaeth. (2002). Impacts of wildfire on soil hydrologic properties of steep sagebrush-steppe rangeland. *International Journal of Wildland Fire* 11: 45-151.

Ehrenfeld J.G. (2003). Effects of exotic plant invasions on soil nutrient cycling processes. *Ecosystems*, 6(6), 503-523.

Ogle S.M., W.A. Reiners, and K.G. Gerow. (2003). Impacts of Exotic Annual Brome Grasses (*Bromus* spp.) on Ecosystem Properties of Northern Mixed Grass Prairie. *American Midland Naturalist* 149: 46-58.

Brooks M.L., D'Antonio CM, Richardson DM, et al. (2004). Effects of invasive alien plants on fire regimes. *BioScience* 54: 677-88.

Norton J.B., T.A. Monaco, J.M Norton, D.A. Johnson, and T.A. Jones. (2004). Soil morphology and organic matter dynamics under cheatgrass and sagebrush-steppe plant communities. *Journal of Arid Environments* 57: 445-466.

Belnap J., Welter, J.R., Grimm, N.B., Barger, N., & Ludwig, J.A. (2005). Linkages between microbial and hydrologic processes in arid and semiarid watersheds. *Ecology*, 86(2), 298-307.

Hooper D.U., Chapin III, F.S., Ewel, J.J., Hector, A., Inchausti, P., Lavorel, S. & Wardle, D.A. (2005). Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. *Ecological monographs*, 75(1), 3-35.

Pierson F.B., Bates, J.D., Svejcar, T.J., & Hardegree, S.P. (2007). Runoff and erosion after cutting western juniper. *Rangeland ecology & management*, 60(3), 285-292.

Sommer M.L., R.L. Barboza, R.A. Botta, E.B. Kleinfelter, M.E. Schauss and J.R. Thompson. (2007). Habitat guidelines for mule deer: California Woodland Chaparral Ecoregion. Mule Deer Working Group, Western Association of Fish and Wildlife Agencies.

Vaness B.M., and Wilson S.D. (2007) Impact and management of crested wheatgrass (*Agropyron cristatum*) in the northern Great Plains. *Canadian Journal of Plant Science*, 87(5): 1023-1028.

Boxell J., and P.J. Drohan. (2008). Surface soil physical properties and hydrological characteristics in *Bromus tectorum* L. (cheatgrass) versus *Artemisia tridentata* Nutt. (big sagebrush) habitat. *Geoderma* 149:305-311.

Herrick J.E., V.C. Lessard, K.E. Spaeth, P.L. Shaver, R.S. Dayton, D.A. Pyke, L. Jolley, and J.J. Goebel. (2010). National ecosystem assessments supported by scientific and local knowledge. *Frontiers in Ecology and the Environment* 8: 403–408.

Pierson F.B., Williams, C.J., Kormos, P.R., Hardegree, S.P., Clark, P.E., & Rau, B.M. (2010). Hydrologic vulnerability of sagebrush steppe following pinyon and juniper encroachment. *Rangeland Ecology & Management*, 63: 614-629.

Davies K.W. (2011). Plant community diversity and native plant abundance decline with increasing abundance of an exotic annual grass. *Oecologia* 167:481-491.

Weltz M.A., Spaeth, K. (2012). Estimating effects of targeted conservation on nonfederal rangelands. *Rangelands*. 34(4):35-40.

Weltz M.A., K. Spaeth, M.H. Taylor, K. Rollins, F. Pierson, L. Jolley, M. Nearing, D. Goodrich, M. Hernandez, S.K. Nouwakpo, and C. Rossi. (2014). Cheatgrass invasion and woody species encroachment in the Great Basin: Benefits of conservation. *J. Soil and Water Cons.* 69:39A-44A.

Send comments and questions to the [NRI Help Desk](#)